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LONG RANGE ACOUSTIC PROPAGATION PROJECT. BLAKE TEST SYNOPSIS REPORT

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Miami University

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Long Range Acoustic Propagation Project

BLAKE TEST Synopsis Report

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TECHNICAL REPORT

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1. Introduction and Executive Summary

The ACODAC exercise known as the BLAKE TEST was an outgrowth of the LRAPP environmental acoustics operation in the Caribbean during the fall of 1972. This exercise raised some questions regarding the self noise of ACODAC systems and the overall performance of the Westinghouse WX-1 VERAY hydrophone array which had broken free and from which no usable data were recovered. The BLAKE TEST also served as a training precursor for the extensive series of ACODAC deployments scheduled for the Pacific in 1973 from R/V NORTH SEAL.

The BLAKE TEST was to consist of five ACODAC array deployments in the area of the BLAKE deep and one current profiling array deployment in the MODE peripheral operating area. The ACODAC array deployments were intended to compare the performance of three basic array configurations in an area of high subsurface currents. The effects on data quality by strumming were to be the primary objectives of the analyses. These configurations included two forms of "hardwire" systems differing in their hydrophones: the WHOI/TI array mounting ITC 8020 hydrophones and the Westinghouse array mounting WX-1 VERAY hydrophones. Also included was a "compliant" system developed at the University of Miami, mounting ITC 8020 hydrophones. Two phases of the acoustic exposure were designed to measure the effects of array shortening on the "hardwire" systems; the compliant array was scheduled to remain undisturbed during the two phases. See Figure 1 for a general description of these five configurations; for a more detailed description see S. C. Daubin "Church Gabro Technical Note Systems Description and Performance." UM-RSMAS-#73040.

The exercise plan was issued on 2 May 1973. The plan included extensive laboratory and dockside system testing and calibration prior to going to sea, the ACODAC acoustic measurements, and a series of eight dives by the Advanced Technology Corporation DSS-2 (Depth Scan System - 2), an acoustic profiling device.

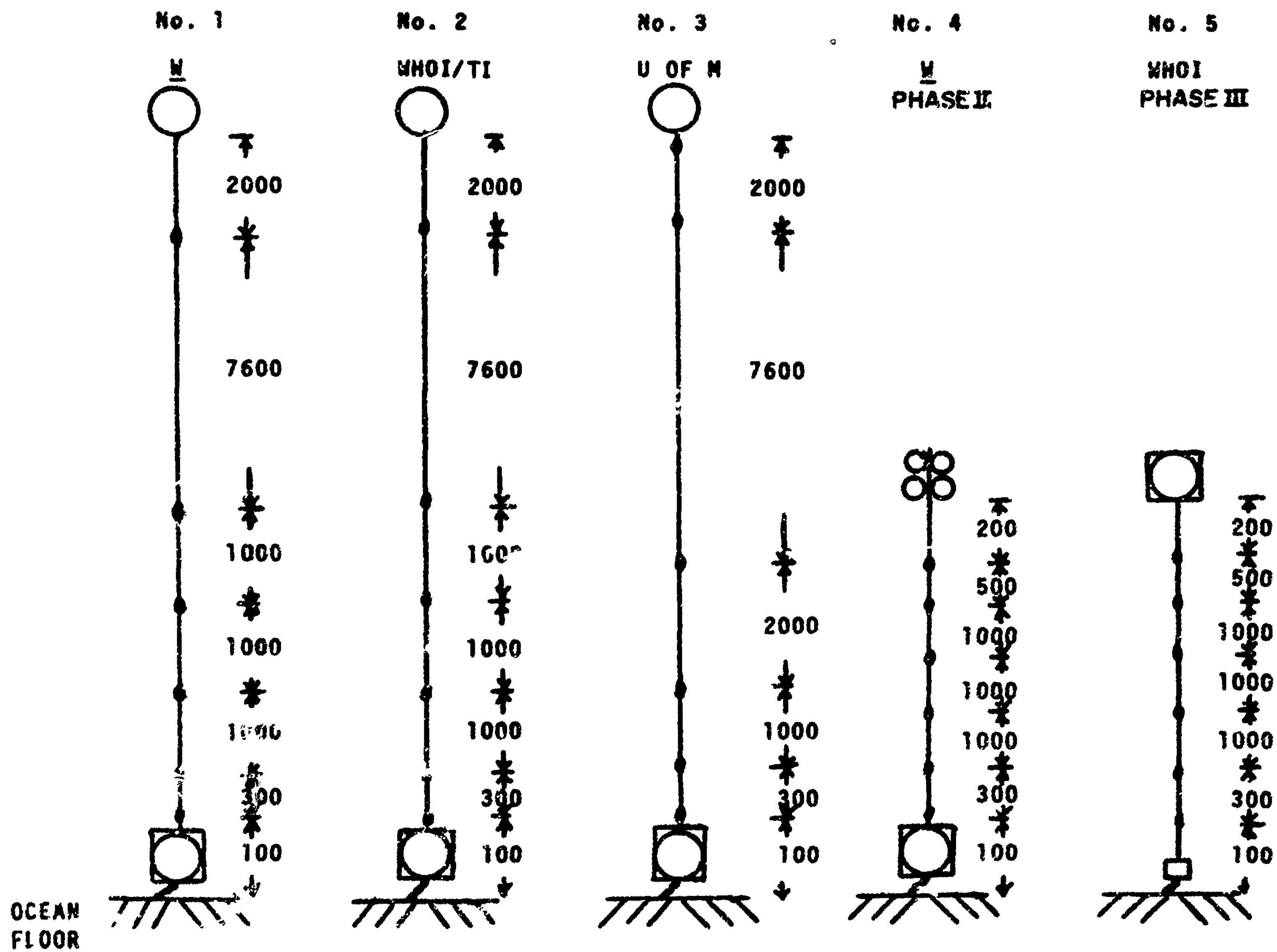

Figure 1. Mooring General Arrangements BLAKE TEST

R/V NORTH SEAL departed Miami for the operating area on 5 June 1973 and returned on 19 June. Four of the five ACODAC array deployments were effected. The current profiling system was set and retrieved as per the schedule. None of the DSS-2 drops were made.

Data were of sufficient quality and quantity to achieve the exercise objectives.

The prime conclusion and recommendation were that strumming did exist to an unacceptable degree and that the quickest effective corrective action would be to desensitize the hydrophones and the data amplifiers in the very low frequency end of the spectrum.

Several deficiencies in ACODAC electronics and in other supporting systems were identified and corrective action recommended.

Shipboard hardware and performance of the deployment crew were evaluated and constructive recommendations presented.

2. Narrative

At 2313Z on 5 June 1973 NORTH SEAL got underway from the NOAA berths, Dodge Island, Miami, Florida. After heading into about 1-1/2 knot of contrary surface current through NW Providence Channel, she arrived at the operating area for Position A early in the morning of June 7. Shortly before this, the echo sounder system ceased giving any trace at all; the last readable depth near Position A was 4568 meters, corrected, at Lat. 26°25.4' N, Long. 74°02.4' W. After running east about 9.3 miles, deployment of the Westinghouse mooring was commenced at 1819Z on 7 June; see Figure 2. The deployment went forward in a routine fashion until 2208Z when an attempt was made to launch the RPM at Lat. 26°25.4' N, Long. 74°00.0' W, just 2.4 miles 000°T from Position A. The quick

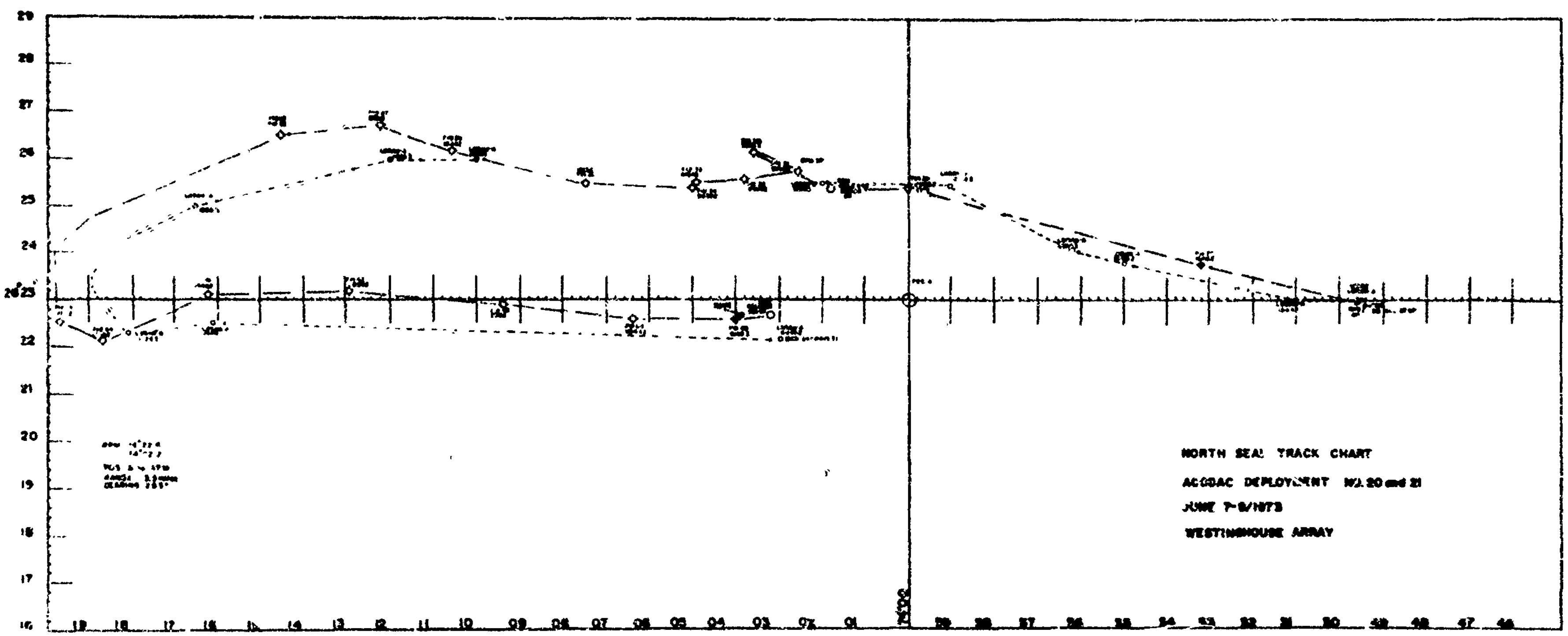

Figure 2. BLAKE TEST Deployment Chart WESTINGHOUSE
Mooring Phase I

release would not operate; after much effort it finally actuated at 2300Z. The surface buoy went under at 2320Z and for a few minutes all appeared well. The last usable AMF range during the sinking phase of the RPM was 2058 meters. Suddenly the radio beacon signal from the surface buoy was heard at 0035Z, 8 June, 75 minutes after the beacon had submerged. By this time darkness had fallen and NORTH SEAL lay off the RPM which had surfaced at 0100Z, waiting for daylight to take it aboard to determine the trouble. The RPM was taken aboard at 1123Z on 8 June; the mooring (Figure 1) was streamed out upwind and did not appear to be fouled or hockled. Investigation found that the Geodyne Model 855 timed release Serial No. 644 had actuated (not fired) due to water pressure entering the firing chamber above the actuating piston, causing the piston to retract. This leakage was past an O-ring in the operating shaft; whether the problem was in the O-ring or in the O-ring surface of the shaft or the housing was not determined. It dawned on us that perhaps this casualty had been the mechanism of the premature release of the Westinghouse mooring at Position H during the CHURCH GABBRO exercise. A long tow was commenced to reverse direction and head back toward the drop site to windward. In the meantime a test of the Geodyne timed release suspended on hydrographic wire was conducted; the instrument fired prematurely soon after going under water. These events raised doubt regarding the reliability of these units, sufficient doubt to cause the Technical Director to decide to eliminate the timed release from all acoustic moorings during the exercise. A second AMF release in parallel with a twin was placed in the place of the timed release. This change eliminated the AMF release from the bottom of the "string" (top of RPM) and constrained all recoveries to contend simultaneously with the RPM and the array. This procedure caused no difficulty. Finally the ship was back in position for launch and a successful up wind anchor drop was made at 0244Z. As seen in Figure 2, the final mooring position was Lat. 26°22.7' N., Long. 74°03.2' W.

Next morning NORTH SEAL took a position 14.2 miles upwind from the intended drop point, and a downwind launch of the Woods Hole/TI array was commenced at 1123Z, 09 June. All went well and at 1728Z the anchor was dropped. However, the RPM continued to float unperturbed; somehow the anchor had separated. Initially the strong opinion held that one of the AMFs had fired because the twin AMF assembly had received a severe jolt as it went over the transom. However, on recovery this opinion was disproved. The AMFs had not released; instead the one inch nylon line between the AMFs and the anchor had thrown a bight around one of the AMFs, passing between the transducer and the tension rod. When the anchor weight was applied the nylon was cleanly cut on an edge of the tension rod standoff bracket. The cause of the casualty had been the sudden deployment of the AMFs which took a considerable bight of line with them prior to the complete slippage of the anchor to the bitterend of its tether. The TI deck supervisor suggested a change in deployment procedure which would have the RPM, the AMFs, the drag chute and all connecting lines streamed in the water prior to the beginning of the anchor release. This change was effected and the second attempt to deploy the Woods Hole/TI mooring was successful at Lat. 26°20.3' N., Long. 74°05.2' W. (Figure 3). However, we were now one anchor short to complete all of the planned deployments. Accordingly, the Technical Director decided to eliminate the Woods Hole/TI phase II deployment which was to be a foreshortened mooring with the RPM at the top; see Figure 1. Since so much frustration had been experienced in obtaining a valid test of the Westinghouse hydrophone array (not all to be blamed on Westinghouse) the Technical Director reasoned that it should receive highest priority for evaluation in this exercise and thus get the maximum exposure to varied conditions.

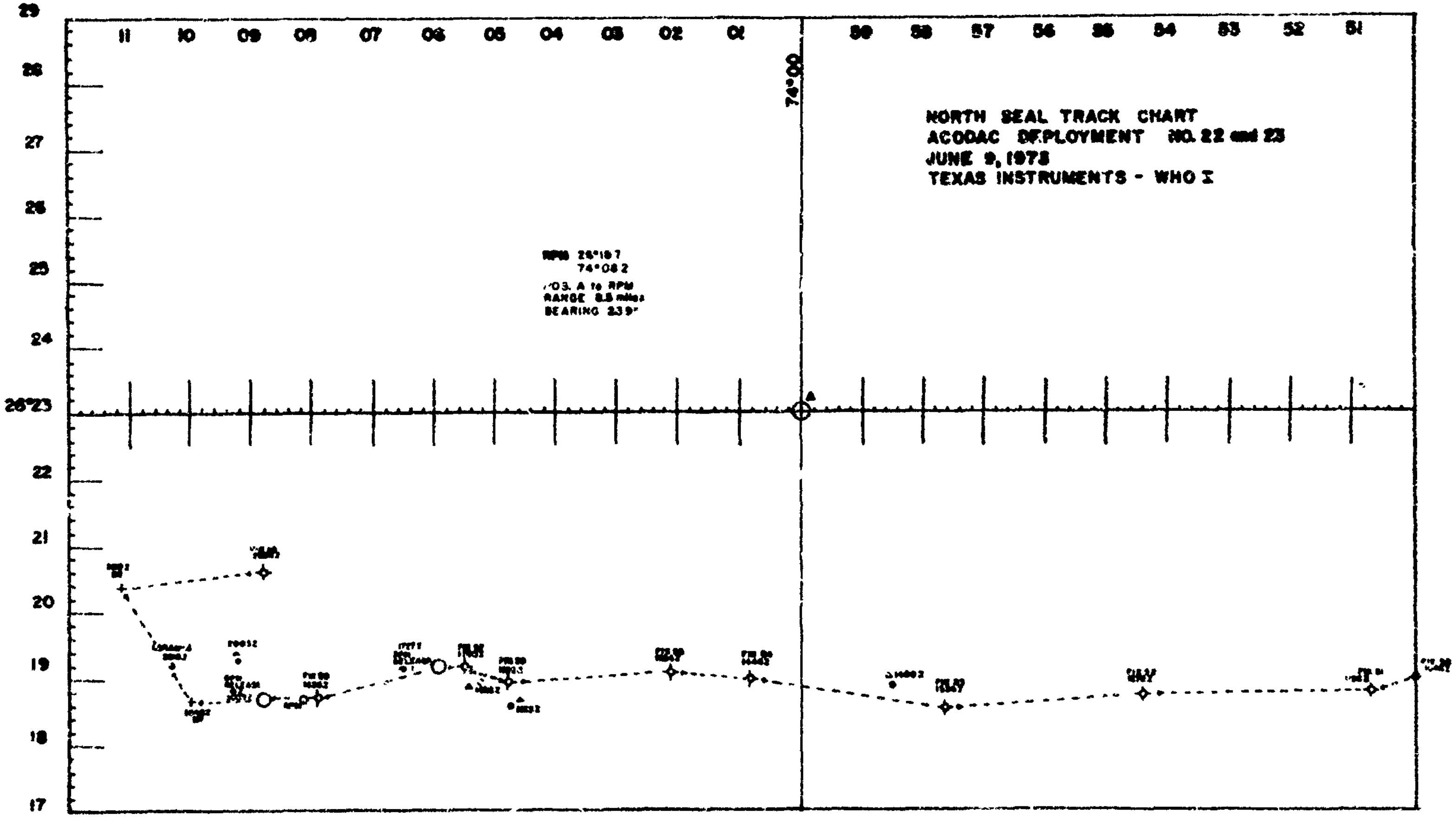

Figure 3. BLAKE TEST Deployment Chart WHOI/TI Mooring

In order to get back on schedule, deployment of the University of Miami compliant array commenced at 0055Z, 10 June, Figures 1 and 4. The target drop point was to be midway between the Westinghouse and Woods Hole/TI moorings. After a false start to correct a lashing problem, getting th two miles of compliant cable with six hydrophones and fifty-seven instruments out of the boxes and into the water went exceptionally fast. The RPM was dropped at 0407Z at Lat. 26°20.3' N., Long. 74°05.2' W. and the surface buoy submerged at 0452°Z 10 June. Within three minutes the surface buoy beacon announced that it was back on the surface. It was now dark and NORTH SEAL took station downwind within sight to await dawn. When morning came, the RPM still had not surfaced and the surface buoy had moved only 0.8 miles to the SE, much less than one would expect from surface drift measurements and in the wrong direction. NORTH SEAL, under the action of wind and current, was drifting approximately west at a steady 1-1/2 knots. NORTH SEAL took the surface float aboard and we proceeded to recover the line by hand to check the tension. After getting about two hundred feet aboard, the line was approximately "up and down" and the tension was reaching more than six men could handle. No one aboard had experienced neutrally buoyant line being "up and down" with over a hundred pounds of tension in the deep ocean. When this observation was coupled with the apparent lack of movement, the Technical Director reached the conclusion that the mooring was still attached to the RPM and that we had inadvertently placed it on an uncharted sea mount. At this point, a working echo sounder would have been most useful to confirm or deny the hypothesis, for the bathymetric chart showed an arc of sea mounts extending into the area from the southeast, although none was shown at our location. With that as the apparently most logical explanation, however far-fetched, of all the strange observables, NORTH SEAL took departure from the area at 1557Z and set course for Point B. That this hypothesis was in error would be learned three days later.

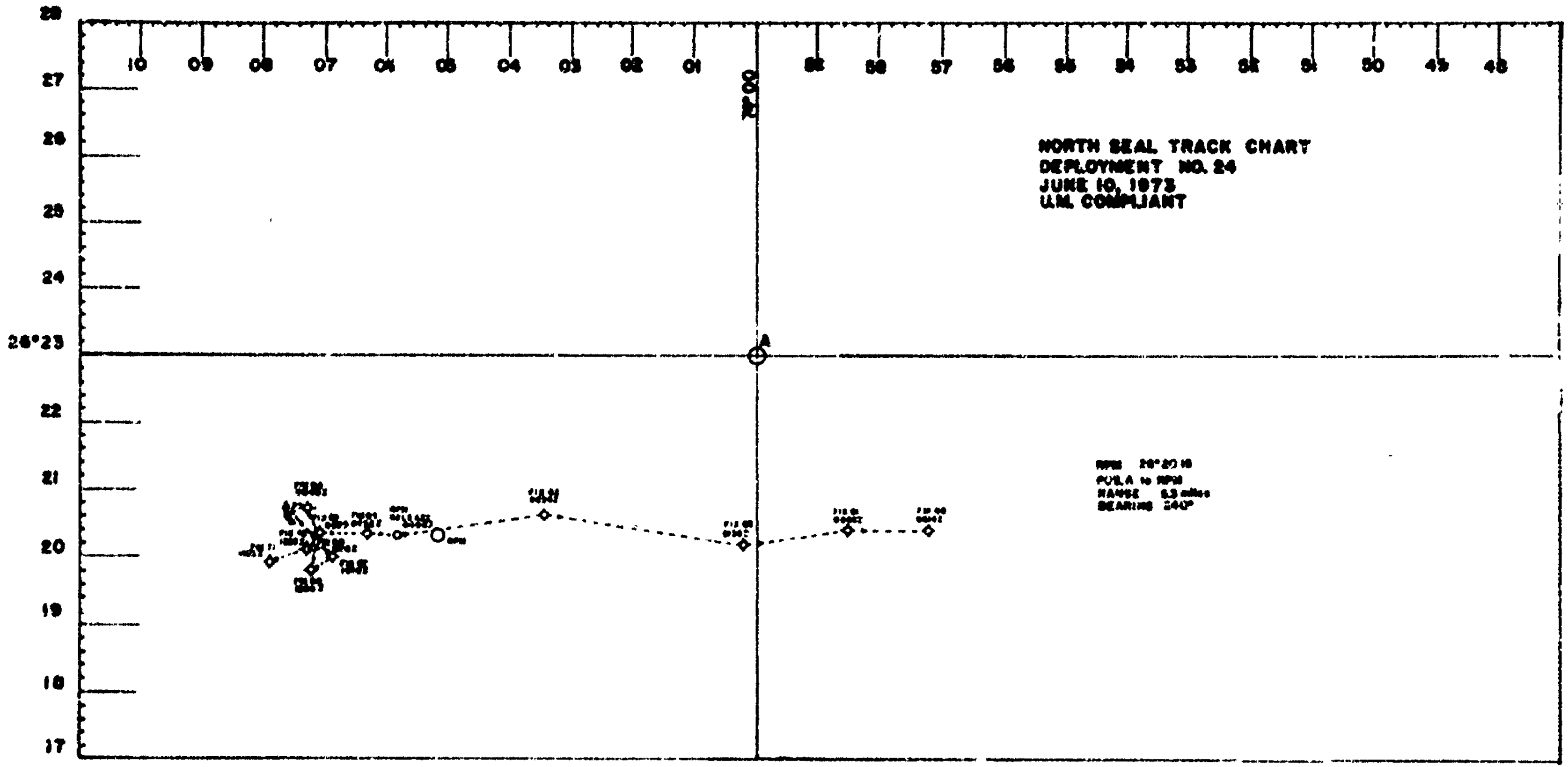

Figure 4. BLAKE TEST Deployment Chart. UM Compliant Mooring

Enroute to Point B groups of SUS charges were dropped at 10, 20, 50, and 100 miles from Point A as per the schedule. At Point B the inclinometer current profiling array was launched at 1524Z on 11 June at Lat. 26°56.0' N., Long. 71°07.9' W. 4.9 miles bearing 250°T from Mooring No. 12 of the MODE experiment against whose current measurements a later comparison was to be made. Since only one acoustic release was available, and the timed release had been previously used successfully, the standard AMF acoustic release paralleled by a Geodyne timed release was employed. From approximately this time until the end of the operation, a period of eight days, the seas flattened out to nearly a dead calm and the winds tended to become light and variable and more southerly. On 11 June an STD was attempted in accordance with the schedule. The STD cast was a complete failure. Both the salinity and temperature pens went through wild depth and parameter fluctuations resulting in a completely unusable trace. These fluctuations were not due to too rapid lowering of the fish, for they occurred also with the winch stopped or with it paying out at a very slow speed (about 10 meters/minute). They became less pronounced and troublesome below a depth of 300 meters. At one point grounding problems on the fish connector were suspected, but this was worked on and checked, and the problem persisted. One thing seems clear: the problem is not in the fish, for reasonable FM signals generated by the in-water unit circuitry were measured by a frequency counter in the operations van. The problem is likely to be found in the recorder. At 2111Z on 11 June after taking several XBTs NORTH SEAL set course 260° to return to the area of Point A. At 0625Z, 12 June NORTH SEAL's automatic course keeping equipment failed; from this point on through the end of the exercise it was necessary to maintain course by hand.

On arrival in the Point A area the first task was to check the status of the supposedly moored surface float of the University of

Miami compliant array. When the ship reached the buoy's previous location it was nowhere to be found. Since the general drift was westerly, we continued in that direction and tuned a sensitive Hallicrafters communications receiver to the radio beacon frequency which was CW with FSK modulation. After proceeding about seven miles a faint signal was heard; the buoy was finally located at Lat. 26°20.3' N., Long. 7[illegible]°17.0' W. about 12 miles west of its previous position. The buoy and the entire mooring were recovered. The failure had occurred at the pigtail attachment to the upper end of the lowest hydrophone. The pigtail of 1/2 inch polypropylene had pulled out of the seizings which attach it to the compliant cable; electrical conductors had parted at the cable connector. Apparently the cable and pigtail were under sufficient load to sensibly reduce the diameter of one or both which cause the seizings to become relatively loose. The failure occurred in the vicinity of the greatest load; as the system falls the lowest part of the cable sees not only static tension but also the total drag force of all the cable above it. When the top buoyancy bag and the marker buoy went under an additional four hundred pounds of static load and several pounds of dynamic load were added; this apparently was enough to push the system past the point of failure. When the recording tensionmeter data are reduced we will have some measure of load seen by the cable. It did not fail during the recent Caribbean exercise because the top buoyancy was about one hundred and fifty pounds less than used here. (The increased buoyancy here was to accommodate the higher expected average currents.) All instruments, except hydrophone No. 6, were attached to the mooring and were recovered successfully. On 13 June the RPM was called to the surface and recovered on board at 1016Z; hydrophone No. 6 was attached.

On 13 June by 1328Z the Westinghouse array was recovered, the upper 7600 foot (2317 meter) section removed, replaced by a 500 foot (152 meter) section reconfigured to Phase II as shown in

Figure 1, and redeployed. The anchor was let go at 1541Z and the Phase II RPM position was Lat. 26°20.1' N., Long 74°09.0' W. (see Figure 5). After a few XBT's were taken NORTH SEAL departed the area for Position B.

Arriving at Position B 15 June, NORTH SEAL consumed a little over a day lying to or maintaining steerageway awaiting the time for recovery of the current profiling system. On 16 June at 0810Z this system was called up and was completely recovered on board by 1158Z. At 1225Z NORTH SEAL set course 255°T to Point A.

NORTH SEAL arrived at the site of the Woods Hole/TI mooring at 0430Z, 17 June. At 0510Z, 17 June NORTH SEAL passed over the mooring and dropped a Mk 64 SUS for depth calibration purposes. At 0800Z, 17 June the RPM and mooring were called up. Recovery was routine and was completed by 101[illegible]Z. It was decided that sufficient daylight remained to recover the Westinghouse Phase II array the same day. At 1439Z, NORTH SEAL passed over the Westinghouse mooring and dropped a calibrating Mk 64 SUS. She then lay off about 3/4 mile to the SE and sent a release command. Since there was no indication of release after a half hour, a release command was sent to the other member of the parallel AMF release package. Still there was no indication of a release. At 1715Z lookouts saw orange floats on the surface and NORTH SEAL moved to investigate. These floats turned out to be fishermen's balls that were directly over the Westinghouse mooring. A third release command was sent to both AMFs at 1[illegible]5Z directly over the mooring. This one was successful and the equipment appeared on the surface and was recovered by 2037Z.

NORTH SEAL waited in the area until 0330Z, 18 June, on the possibility that the DSS-2 equipment would be ready to deploy. Eight drops had been scheduled for the operation, but because the system was not ready, none had been made. At this late hour it

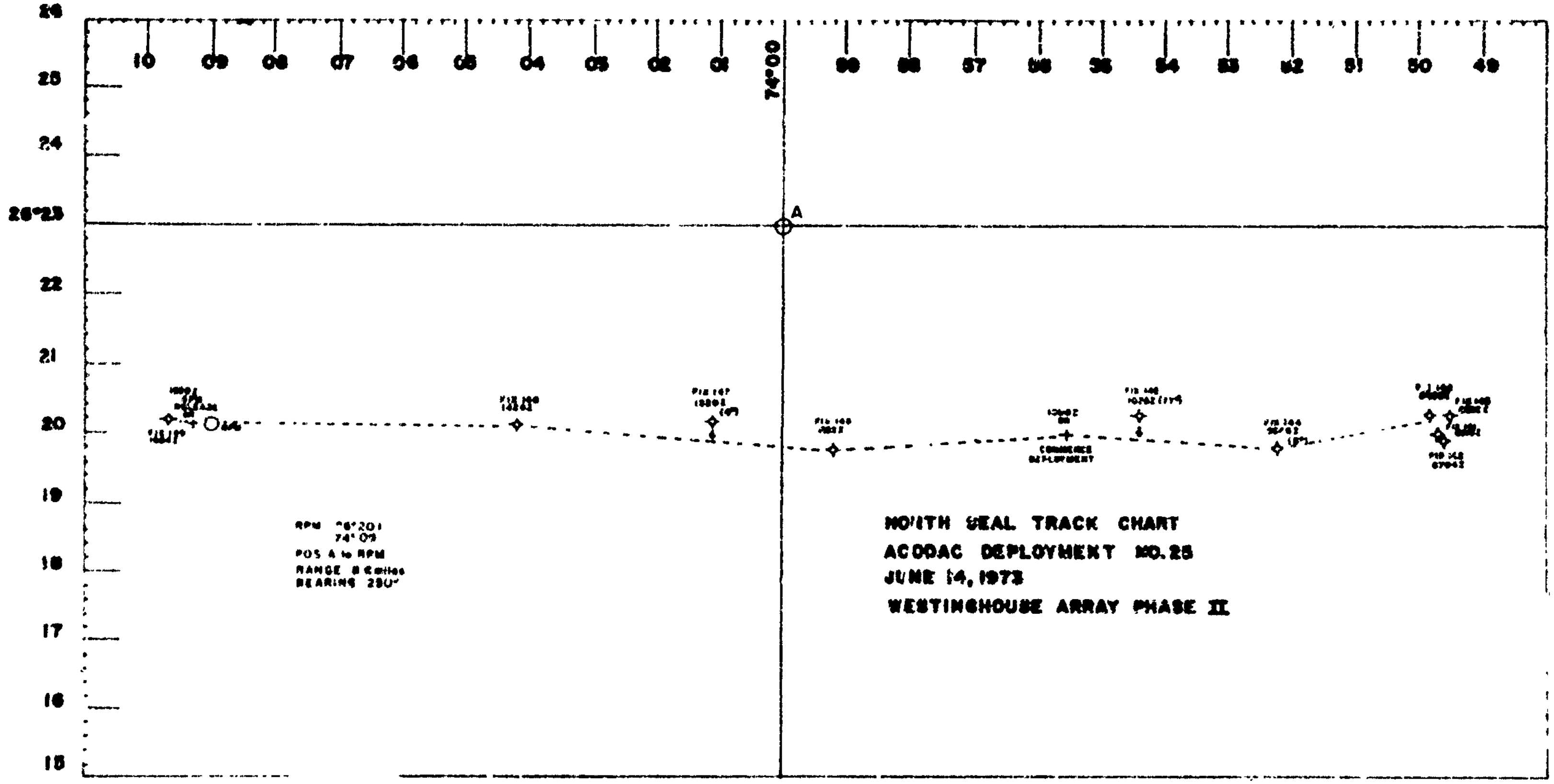

Figure 5. BLAKE TEST Deployment Chart. Westinghouse Mooring Phase II

seemed possible that the system integration would become complete and a dive could be made. However, shortly after the two glass hemispheres had been closed, it was found impossible to turn off the tape recorder remotely Thus the entire DSS-2 mission was scrapped. At 0342Z, 18 June, NORTH SEAL departed the area of Point A and set course for Miami where she arrived at 1400Z on 19 June.

3. Material Performance

3.1 General

The overall material performance of the ship and deployed systems was barely adequate. This rating reflects the fact that all gear which had been committed to the sea was retrieved. Some systems performed well, others failed; the overall margin of performance was too thin. Other closely related failures could have resulted in disaster.

3.2 Deployed Systems

3.2.1 General

These systems include the ACODACs and the current Profiling Array. The ACODAC performance can be broken down into two parts for consideration; mechanical and electrical.

3.2.2 ACODAC Mechanical Performance

This exercise pointed up both the mechanical strengths and weaknesses of the ACODAC systems. Deployment at 4751 meters and recovery without a drop of leakage attested to the basic strength and integrity of the IPV The continued excellent performance of the 7-H-37SB double armored electromechanical cable and its terminations is worthy of note. However, the conditions

which caused failures of the following components need to be rectified:

a. Compliant Pigtail Attachment

The compliant mooring failed due to slippage of seizings which attach pigtails to the electromechanical cable. The slippage was caused by the reduction in cross section of both the pigtail and the electromechanical cable under the dynamic launching loads. The maximum load would be felt at the lower end of the cable which is where the failure occurred. It is necessary to find an attachment which rather than slipping under load, tightens under load. Two possibilities are to knot the pigtail onto the cable by means of a rolling hitch or to join by a braided attachment commonly known as a "Chinese finger". An important consideration in the attachment to the relatively soft compliant cable is to avoid damage in the insulation on the internal conductors. Both of these approaches will be tested and a proved remedy will be provided prior to the next deployment.

b. RPM 2A5 - After the exercise.

This RPM was shipped back to Woods Hole by truck. Upon opening on arrival the arm containing the leak detector electrodes was observed to be bent due to internal contact with an IPV hemisphere; also, a circuit card and numerous nuts and bolts were in the hemisphere, having been vibrated loose.

c. Pressure Proof Electrical Connectors

There were numerous connector problems, most of them were temporarily rectified before the cruise. The most serious was the general failure of the connectors on the Westinghouse hydrophones due to leakage. Interference between the split conical end cap and the polyurethane connector prevented a proper seal. The remedy is obvious: allow sufficient clearance between the end cap and the connector to preclude interference. A second and more general connector problem related to the method of manufacture. In the last batch of connectors manufactured by Environ-Electronics, the material of the shield around the female sockets which prevents intrusion of polyurethane was changed from vinyl to steel. This was a mistake because the metal sleeve apparently did not prevent polyurethane intrusion. The resultant loss of elasticity by the female leaves destroyed the ability of the male-female combination to make good electrical contact. As a temporary remedy the male pins were slightly bent in the middle, thus producing a contact. The manufacturer should revert to the vinyl sleeves and he has agreed to do so.

d. Geodyne Timed Release

Model 855 Serial No. 644 (12 lobed cam) actuated prematurely due to the water pressure entering the firing chamber. The release did not fire, but the pressure was sufficient to cause the piston to withdraw and drop the load. Leakage was past an O-ring on the actuating shaft. It was not resolved whether the problem lay in the O-ring or its mating surfaces. In preparation for Deployment No. 21, Serial No. 646 (12 lobe cam) was put over the side

as part of the AMF operational test; the timed release actuated soon after going under water. The timed release problems cannot be attributed to mis-set time as the proper setting was independently calculated and observed by the CS and the release technician.

e. Surface Marker Buoys and Buoyancy Balls

The surface marker and eleven 17 inch glass balls were lost from the upper end of the mooring in Deployment No. 21. The buoyancy array was clamped to a 1/4 inch neoprene jacketed cable. PLP "hairpins" had been twisted around this cable; glass ball pairs had been clamped on the "hairpins" in the usual way. As a result of the prolonged towing the glass balls slipped on the cable and eventually pushed the surface marker from the end and also allowed eleven balls to become lost. The cause of this failure was insufficient grab of the ball clamps on the wire. First the wire was not of sufficient diameter; second it was rubber jacketed. Ball clamps have been tested to loads of 2000 pounds; with proper installation there should be no slippage under towing conditions. Subsequent deployments used 3/8" 7-H-37SB cable to support the balls. While there was no loss of buoy or balls, the cable did hockle. Satisfactory design of deep top buoyancy using 17" balls still awaits selection; perhaps the use of 4 ball clusters in nylon bags as is done on the compliant array is the answer.

3.2.3 ACODAC Electrical Performance

One of the objectives of the exercise was to search for the effects of strumming. These effects were definitely seen in the records, some times more clearly than at others. The strumming fundamental frequency (estimated from spectral line

frequency separation) was about 1.25 Hz. The actual fundamental was not seen in the spectra due to the low frequency roll-off of the hydrophone/preamplifier. Other than outright overdriving, the most deleterious effect of strumming is to inject sufficient energy into the signal to cause the system to seek an insensitive gain state which then depresses the higher frequency part of the spectrum below system noise.

The location of the most noticeable strumming as seen in LOFAR records would migrate from one hydrophone to another in the Woods Hole/TI mooring. In the University of Miami mooring, no noticeable strumming was evident. In view of the absence of a mooring above the sixth hydrophone, this was not a surprising observation.

After the first calibration sequence a problem developed in the calibration system of hydrophone number six of the WHOI/TI mooring. There seemed to be a loss of synchronization between the level of the calibration signal and the gain state of the amplifier system. This was evidenced by a "finger" appearing in the last quarter of the calibration signature, see Figure 6. This "finger" protruded above the level of the calibration signal which is designed to be level throughout.

Evidence exists of a non-linearity somewhere in the data recording or playback systems. This is manifest in plots of the spectra of calibration signals; Figures 7 and 8, which show not only the 50 Hz and 200 Hz lines, but also the harmonics of 50 Hz (which unfortunately for analytical purposes are also located at difference frequencies). LOFARgrams also always show harmonics of lines; see for example Figure 9. Some harmonic distortion is inevitable and acceptable. As long as the energy in the harmonic stays well below that of the signal, e.g., 30 dB, there is no problem; see Figure 7.

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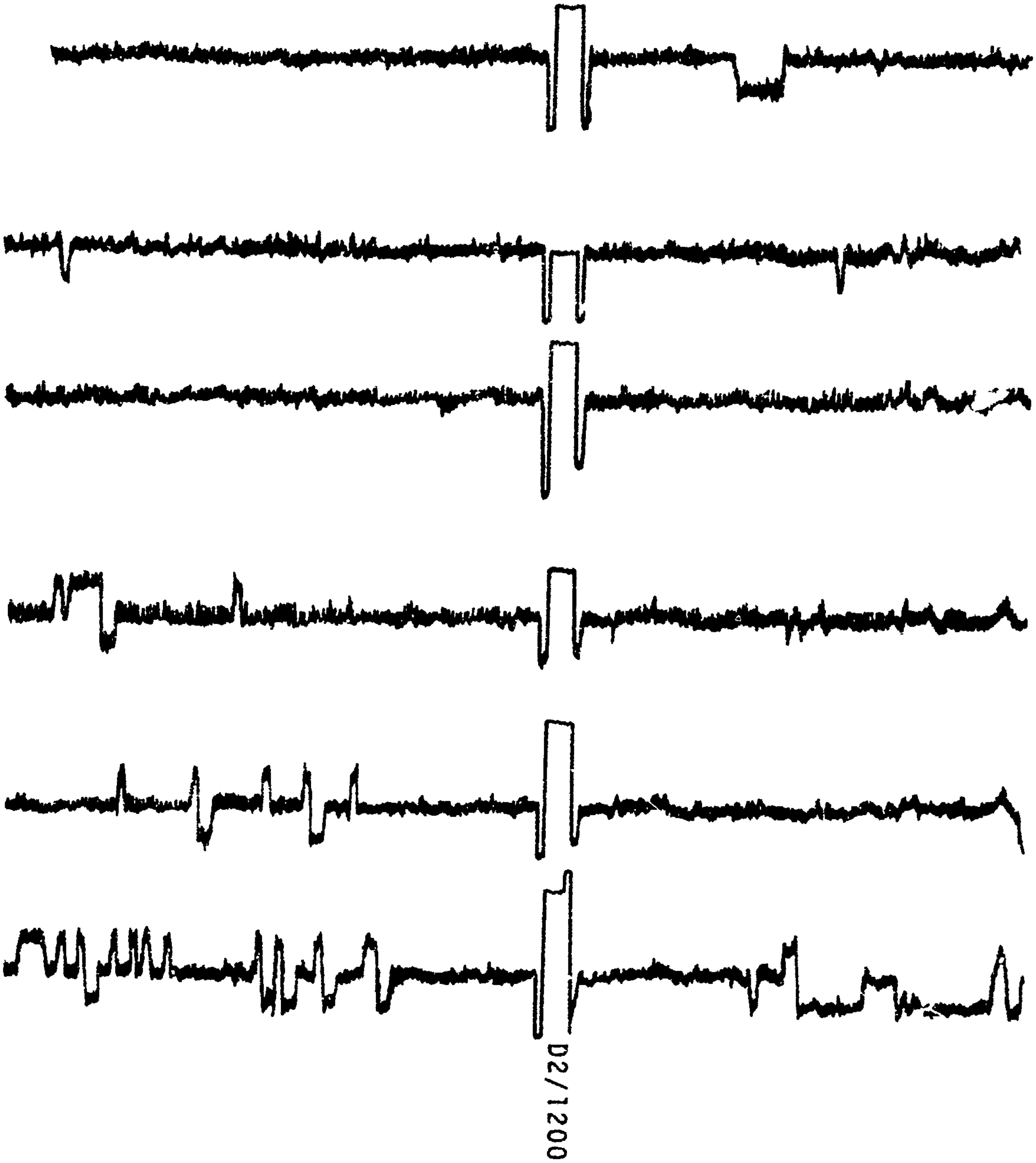

Figure 6. Broadband Time Record Calibration Error

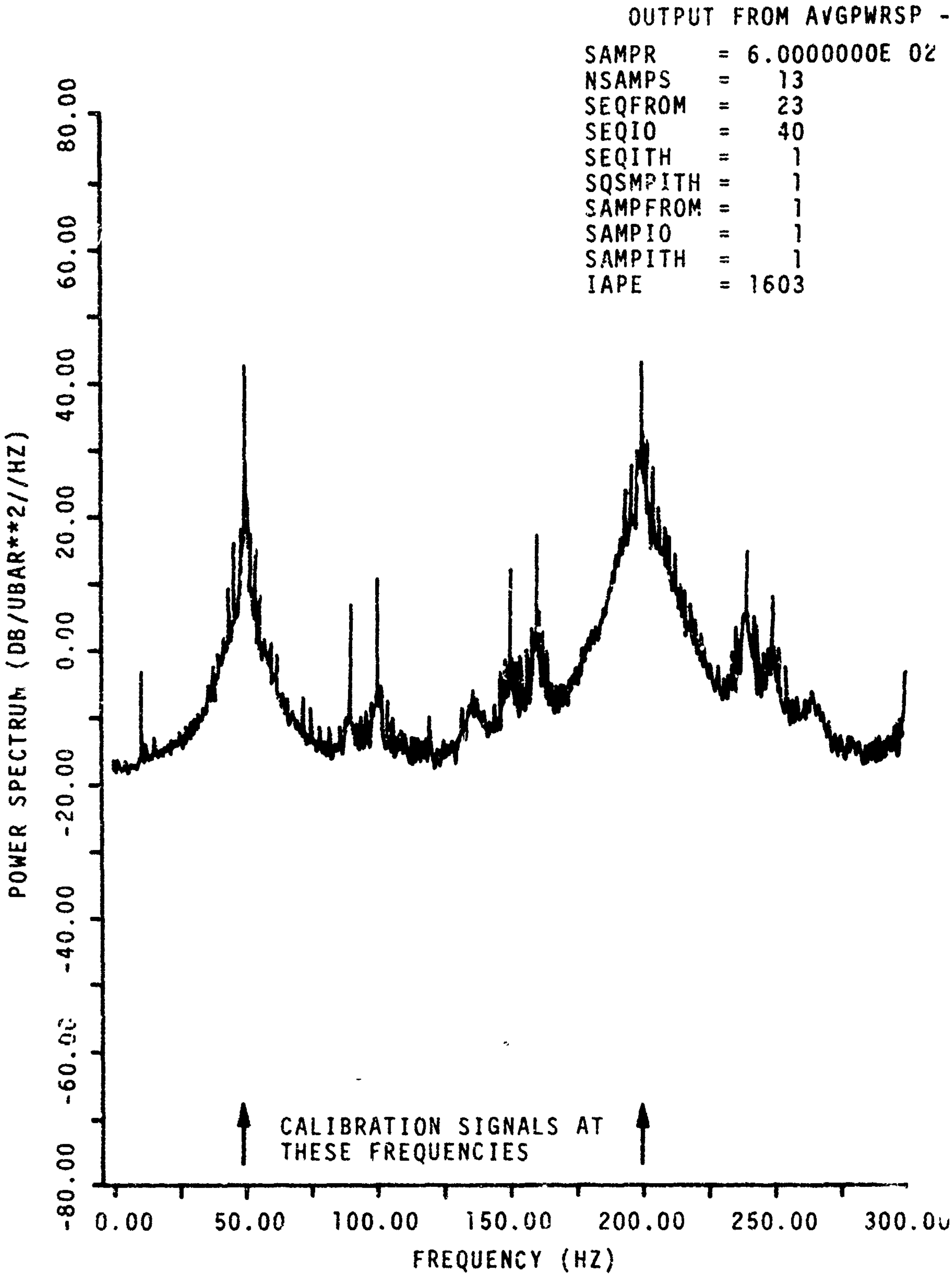

Figure 7. Calibration Sequence Power Spectrum, BLAKE TEST

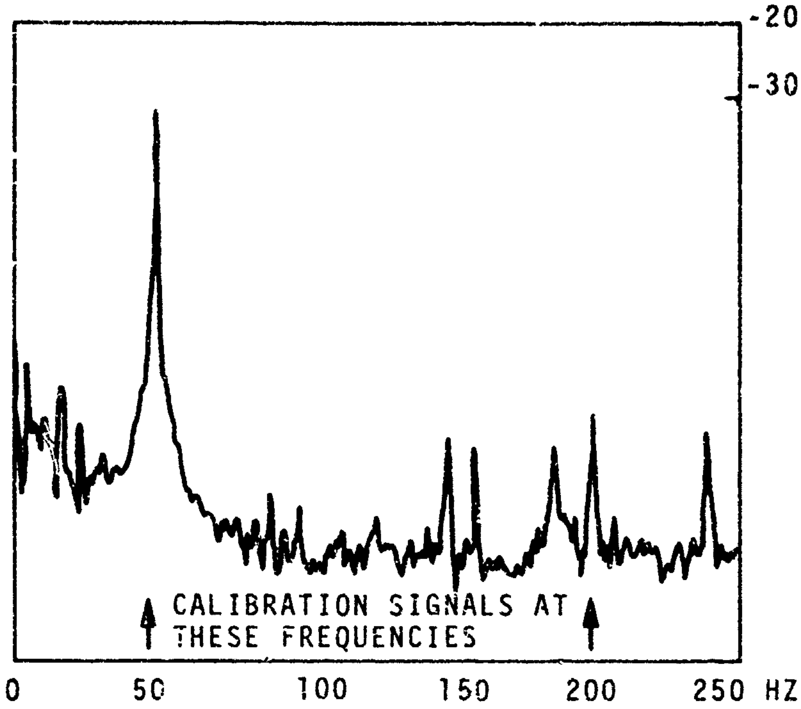

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Figure 8. Calibration Sequence Power Spectrum
BLAKE TEST, RPM 004, 0000Z 13 June

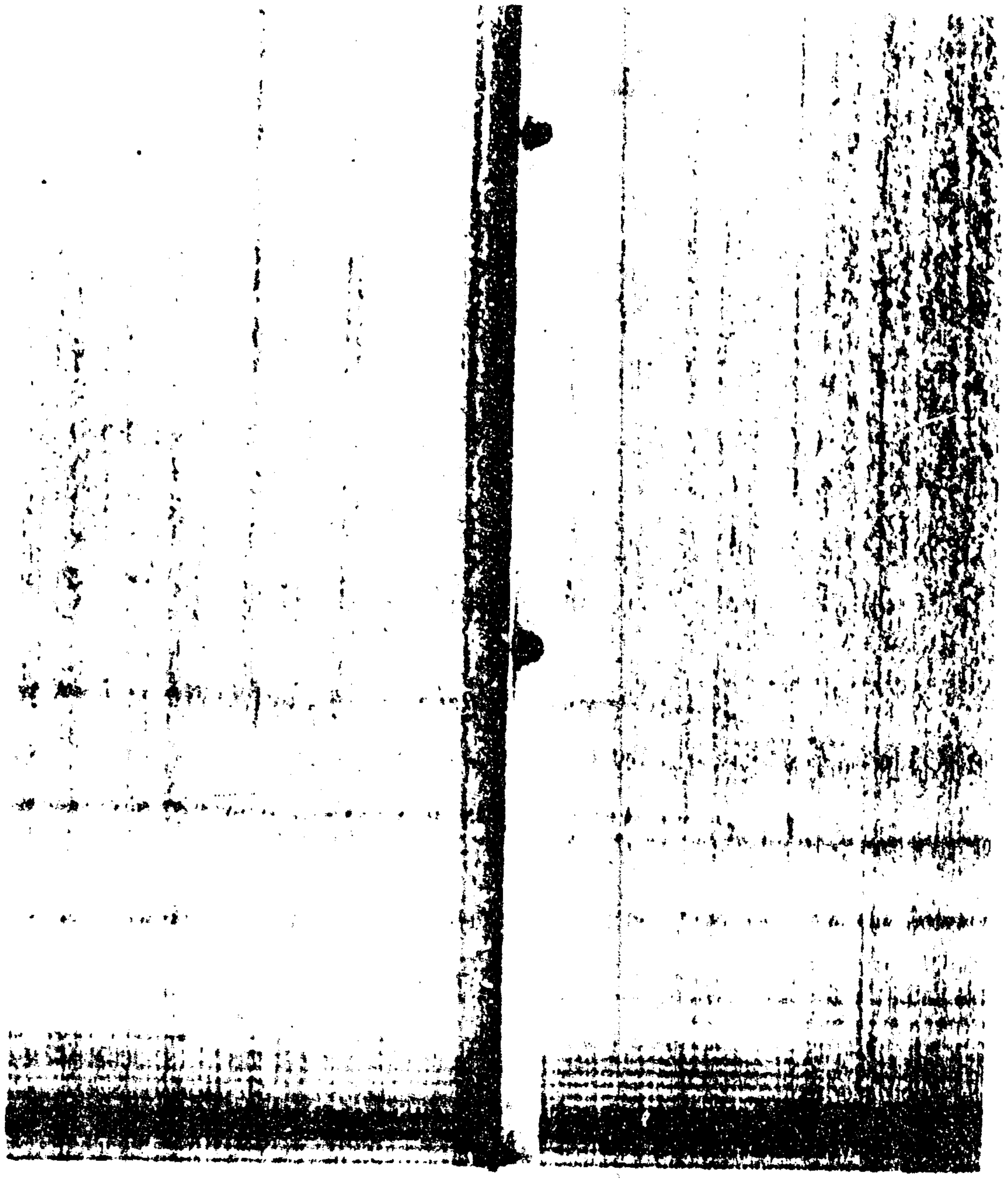


Figure 9. LOFARgram Showing Signal, BLAKE TEST, WHOI/TI Mooring, Hydrophone No. 3

But when the energy in the harmonics approaches that of the signal, Figure 8, an unacceptable data processing situation results.

3.3 Shipboard Systems

3.3.1 XBT

The expendable bathythermograph launcher contacts were corroded, a result of leaving the launcher empty. The breech mechanism was disassembled, the pins cleaned and the system reassembled. During reassembly a guide piece was lost overboard. The launcher operated without that piece, but for future operations it should be reassembled complete with all its pieces. A launcher ground connection, integral to the system calibration, was restored after leaving the dock. Recorder calibrations were attempted, but not completed. The easily accessible screwdriver potentiometer adjustment was made, but the more involved range adjustment was not. As a result, the scale width is out by a few tenths of a degree. This calibration should be completed.

3.3.2 STD

Two attempts to make an STD cast were unsuccessful. Both the "S" and the "T" pens of the recorder oscillated wildly and widely throughout the range of their variable and from the surface to the depth of the fish. The resultant trace was illegible. The system response improved with depth, but the oscillations were always troublesome. Too rapid a sinking (or recovery) rate was not the cause of the problem; the oscillations persisted with the fish held at a fixed depth. At one point it was thought that the problem might be due to an ungrounded connector on the fish but after it was determined that a proper ground existed, the problem remained. Obviously this condition needs to be corrected.

3.3.3 Satellite Navigation

The Magnavox Model 706 CA Satellite Navigator performed adequately during the exercise after some initial problems. When the ship was in Miami before the operation, the program did not load properly; it would "hang up" at a point late in the cycle. A Magnavox service representative visited prior to the sailing and replaced a program tape. During the operation the satellite navigator "bombed out" several times, usually when in the process of calculating a fix. It was always possible to reload and initialize the program, although sometimes this process required several attempts. A diagnostic tape was not on board. In view of the critical importance of the satellite navigator to the success of ACODAC operations, it is recommended that a diagnostic tape be part of the normal equipment. This could save precious time in the event of future trouble.

3.3.4 Omega

The Tracor Omega receiver performed satisfactorily. The North Dakota station (Station D) suddenly went off the air during the ship's Miami check-out period. After spending considerable effort to locate the trouble in the local system, we learned of the temporary shutdown of the station due to a lightening strike. Once the station came back up, Omega worked well. The set's lane recorder calibration potentiometer on the lower of the two lanes would not provide sufficient adjustment, indicating a problem in the recorder electronics power supply.

3.3.5 AMF Acoustic Release

The AMF Model 322 acoustic releases performed barely adequately. In all cases except one, the release function

actuated on the first command; however the transpond function was lost between approximately 2000 and 3000 meters. A typical slant range to the bottom transponder was 5000 meters; the "blind zone" in excess of 3000 meters caused considerable anxiety. It is likely that the problem is one of the received signal to noise ratio at the ship's transducer. Apparently the signal transmitted by the ship produces an adequate signal to noise ratio at the Model 322 release unit. Local propagation conditions, particularly the generation of an afternoon near surface negative gradient due to surface heating by insolation, could result in a serious loss of received signal level. The system should transpond reliably to 9900 meters. One approach toward improving the transpond operation would be to lower the shipboard transducer down through the mixed layer, to about 70 meters.

The one very disturbing case, where several commands were required to actuate the release, occurred on the last recovery. The NORTH SEAL sent three separate release commands from a surface position laterally offset less than a mile from the mooring. Finally a successful release was effected after the NORTH SEAL moved almost directly above the mooring. The contrast between the reliable release actuation of all other receivers and the chancy, frustrating experience of the last one may also be related to the "afternoon effect". All other releases were effected in the pre-dawn hours with surface horizontal ranges of up to a mile and a half. The entire program hangs on the reliability of the acoustic release system; the problem demands solution.

Spare parts for this equipment are noticeably poor. O-rings were purchased just before sailing to complete one unit and a transistor was cannibalized from other equipment (not AMF) for replacement in a release to the deployed. The fact that the release was made to work with the wrong type (2N-number) is a tribute to the ingenuity of the electronic technician but borders on disaster operationally.

3.3.6 OAR Radio Beacon

All but one of these units worked, however the useful range is distressingly short. The shortest range performance was achieved by the fixed shipboard OAR beacon receive system, the next higher ranges were found from the OAR hand held beacon receiver and the longest ranges were measured by the Hallicrafters communications receiver working from a long, fixed antenna. The longest range at which the beacons were detected was of the order of seven miles; the OAR fixed receiver system was limited to about two miles. Why the hand held unit gives better performance than the installed system is not understood, but should be analyzed and corrected. Also, some means should be found to increase the maximum detection range to about double the present value.

3.3.7 Weight Handling Equipment

The weight handling equipment, except for one quick release, worked well. The condition of wire rope needs to be a constant concern of the deck supervisor. The practice of carrying a spare whip for the crane is applauded. Quick releases require proper cleaning, lubrication and testing prior to committing the RPM loads to them.

3.3.8 Steering

NORTH SEAL's automatic course keeping system suffered a casualty which required steering manually for about half of the operation. This was not a vital loss, but it did require considerably more work and attention on the part of the watch. The casualty emphasized the lack of spares and maintenance.

4. Personnel and Operational Performance

4.1 General

One purpose of the BLAKE TEST was to train persons for forthcoming operations in the Pacific. The BLAKE TEST provided

ample opportunity for a crew with little ACODAC handling experience to become competent in deployment and recovery. As measured by the number of anchors used, including the current array, seven separate deployments and five recoveries were made. The TI deck crew included only two persons with previous ACODAC handling experience. By the end of the operation the deck crew had developed sufficient experience and competence to substantiate the expectation of their success in the Pacific. The ship's master had previous ACODAC experience and did an excellent job, particularly in ship handling when coming alongside surfaced arrays. The TI electronics technician group was short in depth, but long on competence, interest, and enthusiasm. Only one technician was in evidence for future cruises with responsibilities in all aspects of the system from the ACODAC to the AMF gear to the satellite navigator. Too much depends on the skill and dedication of the electronics technician not to provide suitable backup in this area.

4.2 Safety

In their zeal to accomplish their tasks the deck handling crew frequently operated on the borderline of the unsafe. Leaning over the transom with neither life jacket nor safety line in order to attach or free line from heavy weights was a common practice. Fortunately the wooden deck of NORTH SEAL provides good footing so no accidents resulted. But the sea state generally approached a dead calm; in higher seas the chance of an accident increases. It was necessary to bring a ship's life ring from the wing of the bridge to the afterdeck. Members of the handling crew frequently stood under heavy weights or in bights. The following procedures are recommended as minimal safety guidelines:

a. Anyone working near the transom should wear an inflatable life jacket and be attached to a safety line.

b. All persons on deck at night should wear life jackets with lights.

c. Two life rings in addition to those on the wings of the bridge should be mounted aft near the transom.

d. Frequent safety instructions should be given to the crew, particularly new members.

e. Frequent inspections of weight handling gear should be made, particularly the crane and winch working wire.

f. Improved boat hooks for grappling gear should be provided.

4.3 Methods

Operational methods were adapted and improved. In particular, the procedures employed during the final phase of deployment were changed. In lieu of burdening the anchor to the RPM prior to launching, the new method let go the RPM and streamed the lower hamper prior to letting go the anchor. In this way the entire deployment could be aborted and gear recovered up until the very last moment: Furthermore, as experience indicated, there was less possibility of a rigging hang up with the gear streamed before letting go the anchor.

The elimination of the timed release removes a possible cause of failure as well as an almost unsoluble problem of "scheduling one's contingencies". The surfacing of the RPM with the array attached caused little difficulty.

5. Data

Data recovered from the Woods Hole/TI array and from hydrophone No. 6 of the Miami array were of sufficient quantity and quality to satisfy the objectives of the exercise. The special nature of this exercise, which was to evaluate the quality of output acoustic data, made any interpretive data useful. Even though there were many periods of strumming in the Woods Hole/TI array, data from these periods were useful in diagnosing the conditions and evaluating their seriousness.

Data were reduced by three organizations, the Woods Hole Oceanographic Institution, the Applied Research Laboratory of the University of Texas and Texas Instruments, Inc; See G. E. Ellis et al, "ARL Preliminary Data Analysis from ACODAC System" ARL-TM-73-11 of 14 June 1973 and "Blake Test Quick Look Report" July 1973, Texas Instrument, Inc. Woods Hole data were reduced and presented in the ACODAC 1/3 octave format. Each one minute average in selected 1/3 octave bands was plotted. The resultant time series were displayed with distribution histograms on the left ordinate. These are shown in Figures 10 and 11. Another form of data was the narrowband power spectrum, produced by FFT. Power spectra of approximately 1/4 Hz and 1/10 Hz resolution were calculated which permitted diagnosis of the sources of certain strumming lines. See Figures 12 and 13. Sequential narrowband spectra constituted the most useful data from ARL/UT and LOFARgrams produced by TI were useful in identifying strumming occurrences and frequencies. See Figures 14 and 15.

6. Conclusions and Recommendations

6.1 Strumming, WHOI/TI Array

Strumming occurred frequently in the hardware WHOI/TI array. At times this strumming prevented the recovery of acoustic

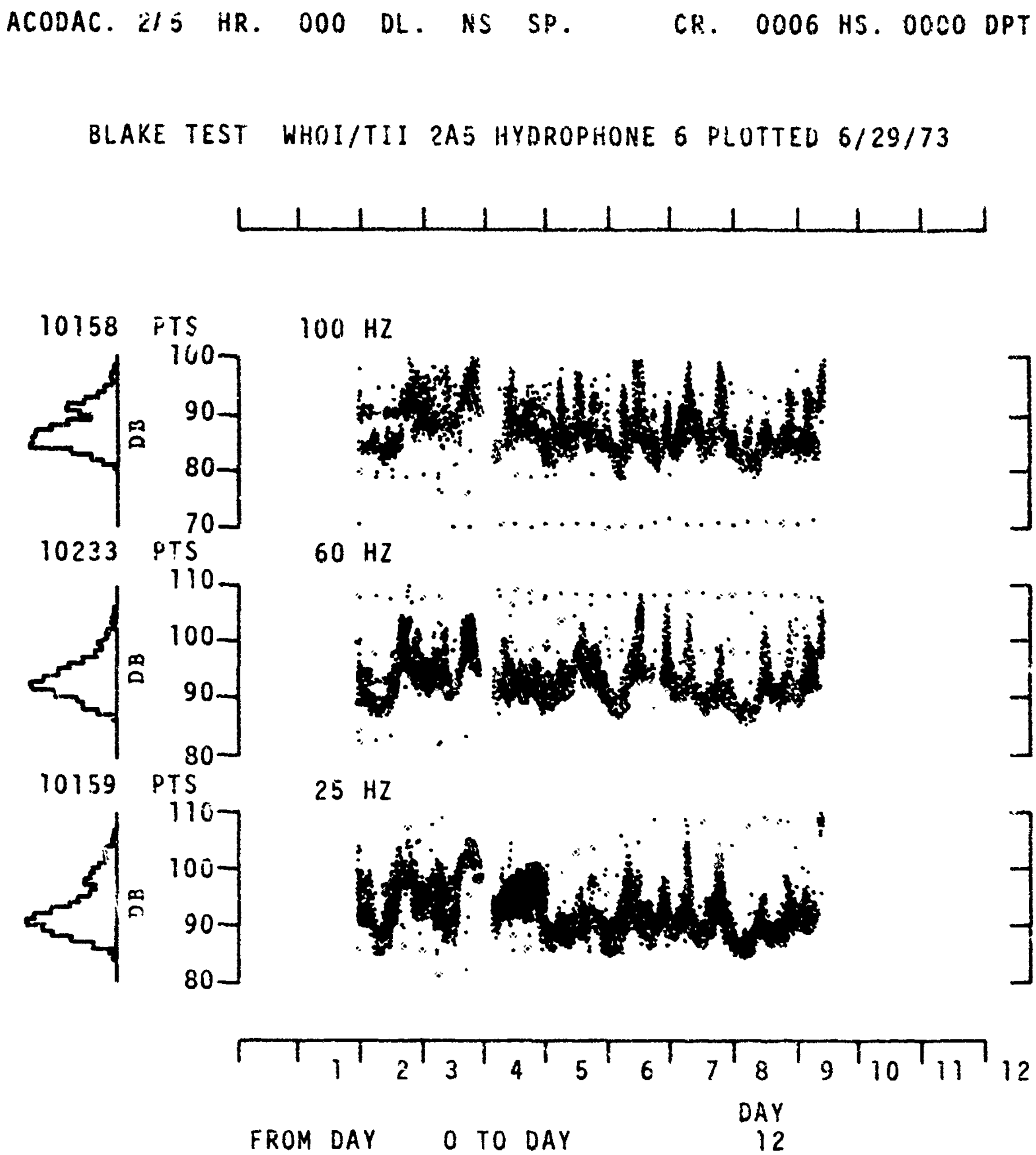


Figure 10. 1/3 Octave Time Series Data BLAKE TEST WHOI/TI Array Hydrophone No. 6

ACODAC 2A4 HR. DL. NS SP. CR. 0006 HS. DPT

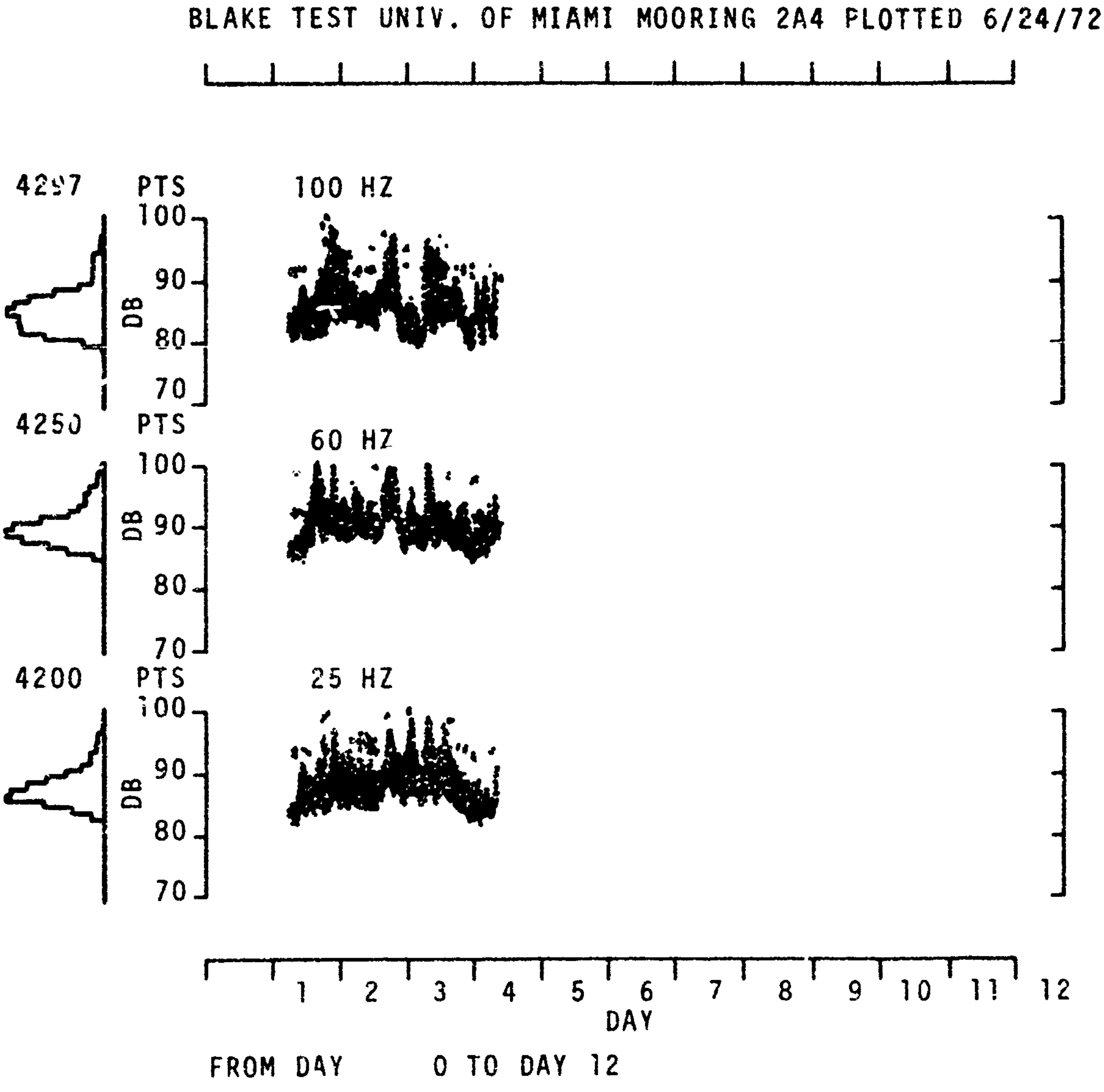
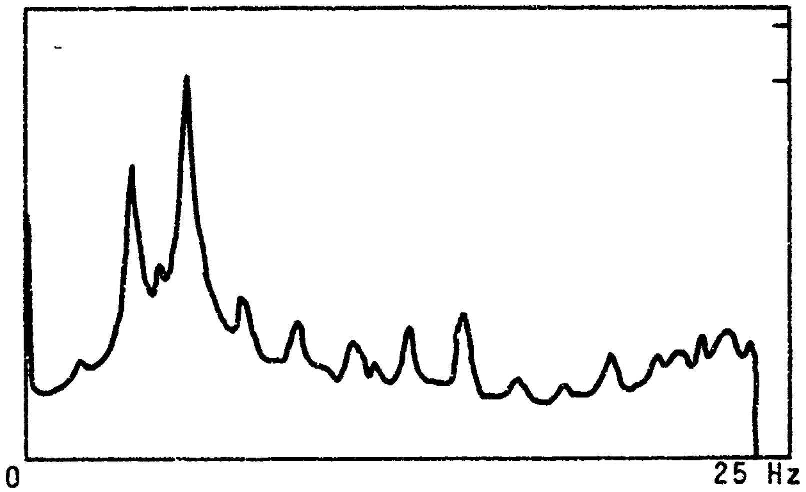


Figure 11. 1/3 Octave Time Series Data. BLAKE TEST UM Compliant Array, Hydrophone No. 6

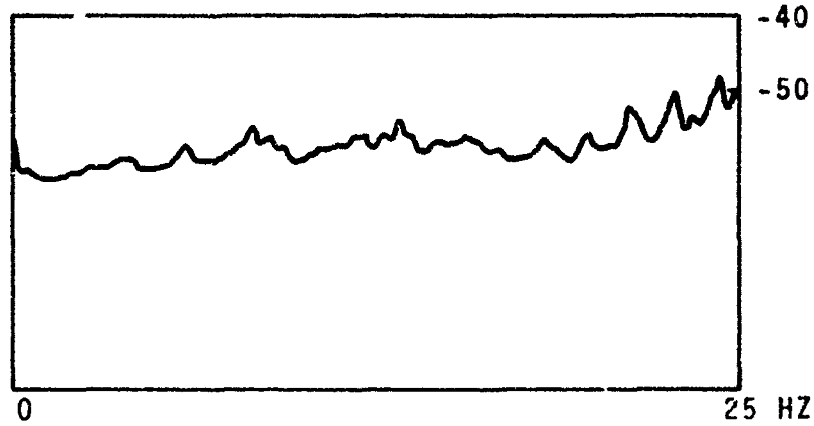


WHOI/TI

$\frac{D4}{2220} - \frac{D4}{2320}$

HYD #6

Figure 12. Narrow Band Power Spectrum 0-25 Hz BLAKE TEST
WHOI/TI Array Hydrophone No. 6 2220Z 12 June



U. MIAMI

1/10 HZ RES.

$\frac{D3}{2220} - \frac{D3}{2320}$

HYD #6

Figure 13. Narrow Band Power Spectrum 0-25 Hz BLAKE TEST UM Compliant Array Hydrophone No. 6 2220Z - 12 June

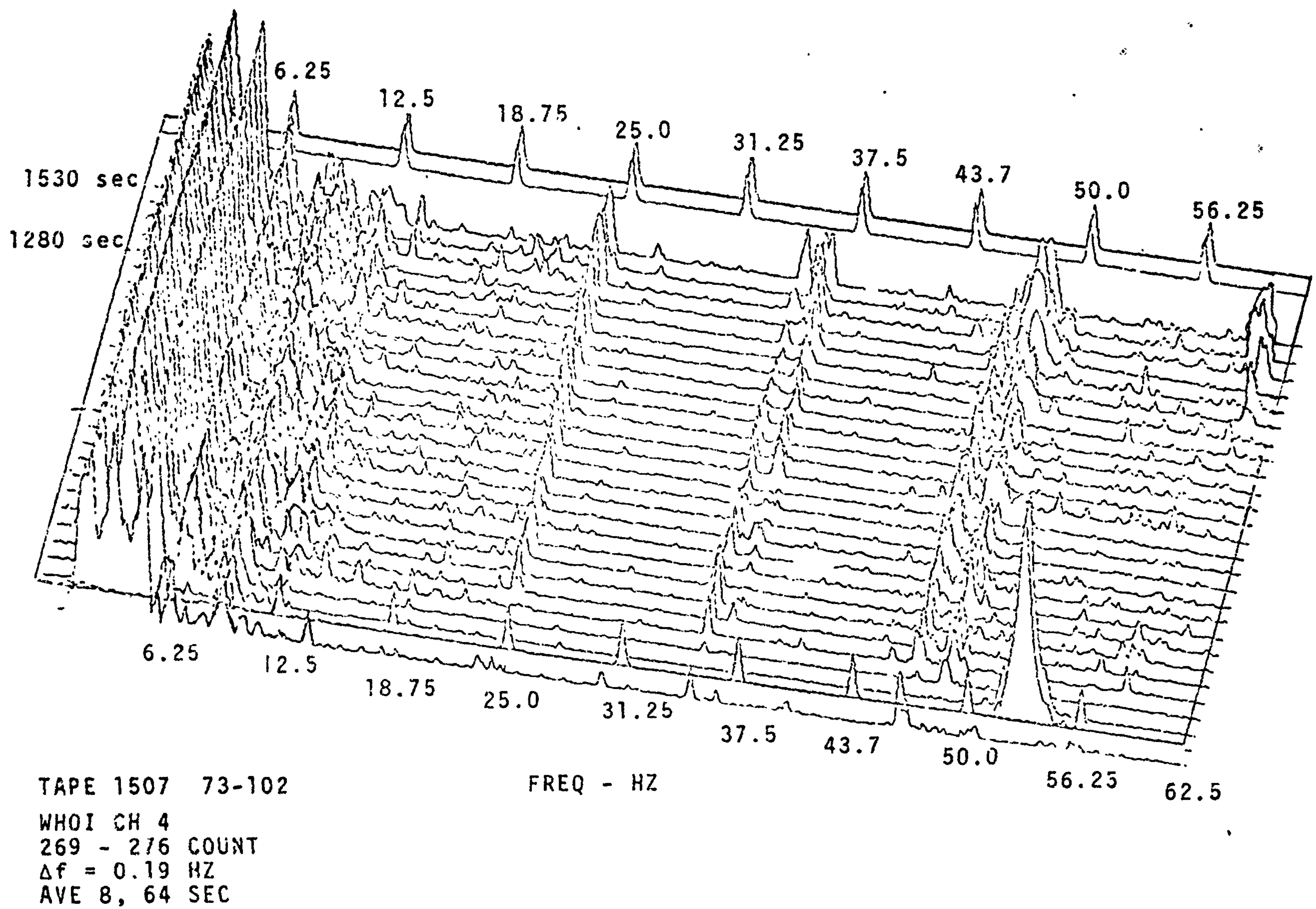


Figure 14. Sequential Power Spectra 0 - 625 Hz BLAKE TEST
WHOI/TI Array, Hydrophone No. 4

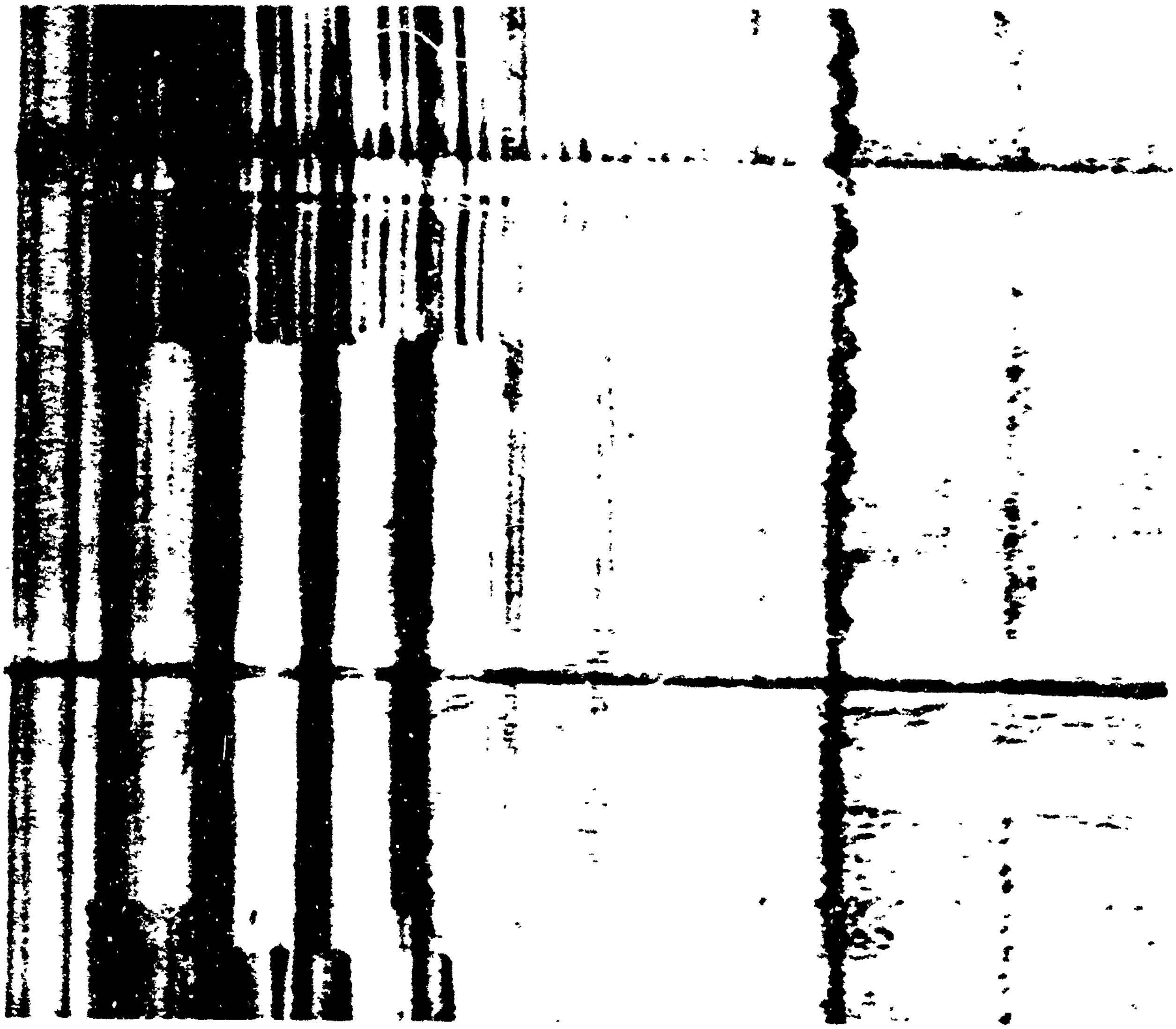


Figure 15. LOFARgram BLAKE TEST WHOI/TI Array, Hydrophone No. 1

data above the strumming frequencies, at other times it did not. To ensure that strumming does not overwhelm the acoustic data the following recommendations are made:

a. De-sensitizing the ITC 8020 hydrophones by moving the mechanical as well as electrical 3 dB down points to approximately 8 Hz.

b. Roll off the RPM data amplifiers at the low frequency end of the spectrum with the 3 dB down point at approximately 8 Hz.

c. Investigate the feasibility and cost of installing mechanical strumming spoilers on the cable in the vicinity of the hydrophones.

6.2 Strumming Westinghouse and UM Compliant Arrays

There is insufficient evidence to evaluate the strumming susceptibility of the University of Miami compliant array. There is insufficient evidence to evaluate any facet of performance of the Westinghouse array. The Westinghouse termination amplifier precludes the prerecording of all frequency (1/3 octave centers) calibration signals, later used for processor calibration, by conventional test equipment. The Westinghouse test equipment (preamps) and adapters should be provided.

6.3 Acceleration Response Calibration

Both the ITC Model 8020 as well as the WX-1 VERRAY hydrophones were designed to discriminate against an acceleration induced response. However, neither of these hydrophones has been

subject to an in water acceleration response test. For evaluating the effects of array strumming, the calibration data on acceleration response would be most useful. It is therefore recommended that prototypes of these hydrophones be tested following a method similar to the method of Marine Physical Laboratory. See Squier, "Survey of Hydrophone Acceleration Responses" SIO Reference 71-19.

6.4 Compliant Array Strength

The strength of the compliant mooring pigtail attachments was proved to be marginal. These need to be redesigned and strengthened. It is recommended that this be done.

6.5 ACODAC Non-Linearities

There exist data processing non-linearities in the ACODAC system. These should be investigated quantitatively as to their effect and removed if necessary.

6.6 Handling Crew

The TI handling crew is competent to execute the forthcoming tests, subject to the following recommendation.

a. More attention to deck safety is required.
b. A greater depth (more persons) of talent in the sea going electronic technician area is required.

6.7 R/V NORTH SEAL Supporting Equipment

R/V NORTH SEAL is a well configured and well handled ACODAC deployment and recovery vessel. The master, mate and chief engineer performed their duties well during the BLAKE TEST and should do likewise in the Pacific. Several shipboard systems need

to be calibrated, repaired or both prior to the Pacific exercies. These include:

a. STD
b. XBT
c. AMF Acoustic Release
d. Echo Sounder

Electronic spare parts for these and ACODAC equipments are completely void aboard ship.

6.8 R/V NORTH SEAL at Sea Repair Capability

R/V NORTH SEAL runs perilously close to a safe borderline in spare parts, as evidenced by the results of the automatic steering failure during the BLAKE TEST. It is recommended that main engine, auxiliary engine and generator, steering and gyro spares be investigated and those vital to continuation of operations be carried.

6.9 Satellite Navigator

The satellite navigator is one of the most critical systems aboard. On its continued operation or expeditious repair could rest the success of the Pacific operations. It is recommended that:

a. A diagnostic tape be carried to identify or locate troubles should they occur.

b. The skill and competence to load programs, initialize and otherwise operate the equipment be provided on board.

6.10 Timed Releases

Timed releases should be avoided if other redundancy can be provided. It is not necessary to bring the mooring up separately from the RPM. It is thus recommended that ACODAC mooring be redesigned to replace the timed release by paralleled acoustic releases, thus eliminating the "upper" acoustic release.

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Declassified LRAPP Documents

Report Number	Personal Author	Title	Publication Source (Originator)	Pub. Date	Current Availability	Class.
Unavailable	Brancart, C. P.	TRANSMISSION REPORT, VIBROSEIS CW ACOUSTIC SOURCE, CHURCH ANCHOR EXERCISE, AUGUST AND SEPTEMBER 1973	B-K Dynamics, Inc.	730101	AD0528904	U
Unavailable	Daubin, S. C., et al.	LONG RANGE ACOUSTIC PROPAGATION PROJECT. BLAKE TEST SYNOPSIS REPORT	University of Miami, Rosenstiel School of Marine and Atmospheric Science	730101	AD0768995	U
NUSC TR NO. 4457	King, P. C., et al.	MOORED ACOUSTIC BUOY SYSTEM (MABS): SPECIFICATIONS AND DEPLOYMENTS	Naval Underwater Systems Center	730105	AD0756181; ND	U
MC-012	Unavailable	CHURCH GABBRO SYNOPSIS REPORT (U)	Maury Center for Ocean Science	730210	ND	U
Unavailable	Hecht, R. J., et al.	STATISTICAL ANALYSIS OF OCEAN NOISE	Underwater Systems, Inc.	730220	AD0526024	U
Raff rept 73-2	Bowen, J. I., et al.	EASTLANT SHIPPING DENSITIES	Raff Associates, Inc.	730227	ND	U
Unavailable	Sander, E. L.	SHIPPING SURVEILLANCE DATA FOR CHURCH GABBRO	Raff Associates, Inc.	730315	AD0765360	U
Unavailable	Wagstaff, R. A.	RANDI: RESEARCH AMBIENT NOISE DIRECTIONALITY MODEL	Naval Undersea Center	730401	AD0760692	U
Unavailable	Van Wyckhouse, R. J.	SYNTHETIC BATHYMETRIC PROFILING SYSTEM (SYNBAPS)	Naval Oceanographic Office	730501	AD0762070	U
MCPLAN012	Unavailable	SQUARE DEAL EXERCISE PLAN (U)	Maury Center for Ocean Science	730501	NS; ND	U
Unavailable	Marshall, S. W.	AMBIENT NOISE AND SIGNAL-TO-NOISE PROFILES IN IOMEDEX	Naval Research Laboratory	730601	AD0527037	U
Unavailable	Daubin, S. C.	CHURCH GABBRO TECHNICAL NOTE: SYSTEMS DESCRIPTION AND PERFORMANCE	University of Miami, Rosenstiel School of Marine and Atmospheric Science	730601	AD0763460	U
MC-011	Unavailable	CHURCH ANCHOR EXERCISE PLAN (U)	Maury Center for Ocean Science	730601	ND	U
Unavailable	Solosko, R. B.	SEMI-AUTOMATIC SYSTEM FOR DIGITIZING BATHYMETRY CHARTS	Calspan Corp.	730613	AD0761647	U
64	Jones, C. H.	LRAPP VERTICAL ARRAY- PHASE II	Westinghouse Research Laboratories	730613	AD0786239; ND	U
Unavailable	Koenigs, P. D., et al.	ANALYSIS OF PROPAGATION LOSS AND SIGNAL-TO-NOISE RATIOS FROM IOMEDEX	Naval Underwater Systems Center	730615	AD0526552	U
NUSC TR 4417	Perrone, A. J.	INFRASONIC AND LOW-FREQUENCY AMBIENT-NOISE MEASUREMENTS OFF NEWFOUNDLAND	Naval Underwater Systems Center	730619	ND AD913868	U
USRD Cal. Report No. 3576	Unavailable	CALIBRATION OF FLIP-CHURCH ANCHOR TRANSDUCERS SERIALS 15 AND 19	Naval Research Laboratory	730716	ND	U